DECLARATION

I, Yoshitaro Nobuta of c/o SHIGA INTERNATIONAL PATENT OFFICE, 1-9-2 Marunouchi, Chiyoda-ku, Tokyo 100-6620 JAPAN, understand both English and Japanese, am the translator of the English document attached, and do hereby declare and state that the attached English document contains an accurate translation of the official certified copy of Japanese Patent Application No. 2003-085423 and that all statements made herein are true to the best of my knowledge.

Declared in Tokyo, Japan

This 1st day of September, 2010

Y. Nobuta

Yoshitaro Nobuta

JAPAN PATENT OFFICE

This is to certify that the annexed is a true copy of the following application as filed with this office.

Date of Application	:	March 26, 2003
Application Number	:	Patent Application No. 2003-085423
[ST. 10/C]	:	[JP2003-085423]
Applicant(s)	:	Nippon Telegraph and Telephone Corporation

Date: April 28, 2004

Commissioner,
Japan Patent Office Yasuo IMAI

No. 2004-3036660

(Title of the Document) Patent Application

(Docket Number) NTTH147231

(Filing Date) March 26, 2003

(Destination) Commissioner, Japan Patent Office, Shinichiro Ohta

(International Classification) H04L 12/66

(Inventor)
(Address) c/o Nippon Telegraph and Telephone Corporation, 3-1, Otemachi 2-chome, Chiyoda-ku, Tokyo
(Name) Eiji OKI

(Inventor)
(Address) c/o Nippon Telegraph and Telephone Corporation, 3-1, Otemachi 2-chome, Chiyoda-ku, Tokyo
(Name) Daisaku SHIMAZAKI

(Inventor)
(Address) c/o Nippon Telegraph and Telephone Corporation, 3-1, Otemachi 2-chome, Chiyoda-ku, Tokyo
(Name) Kohei SHIOMOTO

(Inventor)
(Address) c/o Nippon Telegraph and Telephone Corporation, 3-1, Otemachi 2-chome, Chiyoda-ku, Tokyo
(Name) Naoaki YAMANAKA

(Applicant for Patent)
(Identification Number) 000004226
(Address) 3-1, Otemachi 2-chome, Chiyoda-ku, Tokyo
(Name) Nippon Telegraph and Telephone Corporation

(Agent)
(Identification Number) 100078237
(Address) 26-18, Sekimachi Kita 2-chome, Nerima-ku, Tokyo
(Patent Attorney)
(Name) Naotaka IDE
(Telephone number) 03-3928-5673

(Elected Agent)
(Identification Number) 100083518
(Address) 26-18, Sekimachi Kita 2-chome, Nerima-ku, Tokyo
(Patent Attorney)

(Name) Toshinao SHIMODAIRA
(Telephone number) 03-3928-5673

(Official Fee)
(Prepayment Docket Number) 014421
(Amount of Payment) ¥21,000

(List of Documents Submitted)
(Item) Specification 1
(Item) Drawing 1
(Item) Abstract 1
(General Power of Attorney Number) 9701394

(Necessity of Proof) Yes

Patent Application No. 2003-085423

Information on Applicant

Identification Number		(000004226)
1.	Renewal Date	July 15, 1999
	(Reason)	Renewal
	Address	3-1, Otemachi 2-chome, Chiyoda-ku, Tokyo
	Name	Nippon Telegraph and Telephone Corporation

[Title of the Document] SPECIFICATION

[Title of the Invention] GMPLS EDGE NODE AND IP/MPLS EDGE NODE

[Claims]

[Claim 1] A GMPLS edge node which is used in a network in which a GMPLS (Generalized Multi Protocol Label Switching) network and an IP (Internet Protocol) network are mixed, the GMPLS network comprising a GMPLS node, the IP network comprising an IP/MPLS (Internet Protocol/Multi Protocol Label Switching) node, and which constitutes the GMPLS network, and which is directly connected to the IP network, the GMPLS edge node comprising:

a device which establishes a GMPLS label path of a packet layer with another GMPLS edge node in the GMPLS network; and

a device which tunnel transfers a packet transferred from the IP/MPLS node with the other GMPLS edge node through the GMPLS label path.

[Claim 2] A GMPLS edge node according to claim 1, further comprising a device which advertises link state information of the GMPLS label path of the packet layer to the IP/MPLS node by a router LSA (Label Switching Advertisement) as a normal link in the IP/MPLS node.

[Claim 3] A GMPLS edge node according to claim 2, further comprising:

a device which holds the link state information having the GMPLS label path of the packet layer advertised as the link; and

a device which holds link state information inside of the GMPLS network.

[Claim 4] A GMPLS edge node according to claim 2, further comprising a device which converts a link of PSC-LSP (Packet Switch Capable-Label Switch Path) used for IP/MPLS from an unnumbered system into a numbered system to advertise as the link of the numbered system.

[Claim 5] A GMPLS edge node according to claim 2, further comprising:

a device which performs processing inside of the GMPLS network in accordance with an unnumbered system; and

a device which converts a link of PSC-LSP used for IP/MPLS from the unnumbered system into a numbered system to advertise as the link of the numbered system.

[Claim 6] A GMPLS edge node according to claim 2, further comprising a device which

advertises the GMPLS label switch path of the packet layer as a link of a numbered system.

[Claim 7] A GMPLS edge node according to claim 2, further comprising:

a device which performs processing inside of the GMPLS network in accordance with an unnumbered system; and

a device which converts the GMPLS label switch path of the packet layer from the unnumbered system into a numbered system to advertise as the link of the numbered system.

[Claim 8] A GMPLS edge node according to any one of claim 4 through claim 7, further comprising:

a device which previously stores an IP address; and

a device which uses the stored IP address as an IP address of the link of the numbered system.

[Claim 9] An IP/MPLS node which is used in a network in which a GMPLS network and an IP network are mixed, the GMPLS network comprising a GMPLS node, the IP network comprising an IP/MPLS node, and which is connected to the GMPLS network, and a GMPLS edge node which constitutes the GMPLS network and which is directly connected to the IP network establishes a GMPLS label path of a packet layer with another GMPLS edge nodes in the GMPLS network,

the IP/MPLS node comprising a device which holds link state information having a GMPLS label path of the packet layer advertised as a link.

[Claim 10] A network in which GMPLS and IP/MPLS are mixed, comprising:

a GMPLS edge node according to any one of claim 1 through claim 8; and

an IP/MPLS node according to claim 9.

[Claim 11] A packet communication method in a network in which a GMPLS network and an IP network are mixed, the GMPLS network comprising a GMPLS node, the IP network comprising an IP/MPLS node, and the IP/MPLS node transfers a packet with the GMPLS node, the packet communication method comprising:

a step of providing a GMPLS edge node which is directly connected to the IP network among GMPLS nodes constituting the GMPLS network;

a step of establishing a GMPLS label path of a packet layer with another GMPLS edge node in the GMPLS network by the GMPLS edge node; and

a step of tunnel transferring a packet transferred from the IP/MPLS node with the other GMPLS edge node through the GMPLS label path.

[Claim 12] A packet communication method according to claim 11, wherein link state information of the GMPLS label path of the packet layer is advertised to the IP/MPLS node by a router LSA as a normal link in the IP/MPLS node.

[Claim 13] A packet communication method according to claim 12, wherein link state information having the GMPLS label path of the packet layer advertised as the link is held, and link state information inside of the GMPLS network is held.

[Claim 14] A packet communication method according to claim 12, wherein a link of PSC-LSP used for IP/MPLS is converted from an unnumbered system into a numbered system and is advertised as the link of the numbered system.

[Claim 15] A packet communication method according to claim 12, wherein the GMPLS network performs processing in accordance with an unnumbered system, and a link of PSC-LSP used for IP/MPLS is converted from the unnumbered system into a numbered system and is advertised as the link of the numbered system.

[Claim 16] A packet communication method according to claim 12, wherein the GMPLS label switch path of the packet layer is advertised as the link of a numbered system.

[Claim 17] A packet communication method according to claim 12, wherein the GMPLS network performs processing in accordance with an unnumbered system, and the GMPLS label switch path of the packet layer is converted from the unnumbered system into a numbered system, and is advertised as the link of the numbered system.

[Claim 18] A packet communication method according to any one of claim 14 through claim 17, wherein an IP address is previously stored, and the stored IP address is used as an IP address of the link of the numbered system.

[Claim 19] A packet communication method, wherein the IP/MPLS node holds link state information having the GMPLS label path of the packet layer advertised as a link.

[Claim 20] A method for configuring a network in which GMPLS and IP/MPLS are mixed, comprising:

providing a GMPLS node which transfers a packet using a packet communication method according to any one of claim 11 through claim 18; and

providing an IP/MPLS node which transfers a packet using a packet

communication method according to claim 19.

[Detailed Description of the Invention]

[0001]

[Technical Field]

The present invention relates to a connection scheme between networks using different switching schemes. Particularly, the present invention relates to a network where GMPLS (Generalized Multi-Protocol Label Switching) networks and IP/MPLS (Internet Protocol/Multi-Protocol Label Switching) networks are mixed.

[0002]

[Background Art]

A conventional network comprising IP/MPLS nodes is shown in FIG. 12. In the network within the IP/MPLS, the switching capability of the node interface is all PSC (Packet Switching Capable). MPLS architecture is defined in order to support data transfer based on labels (for example, refer to Non Patent Document 1). In RFC3031, an LSR (Label Switching Router) means a node which has a data transfer plane which can identify the border of an IP packet or a cell (labeled IP packet), and which performs data transfer processing according to the contents of the IP packet header or cell header. In GMPLS, the LSR is not only the node that performs data transfer processing according to the contents of the IP packet header or cell header. The LSR in GMPLS includes a device which performs transfer processing based on the information of a time slot, a wavelength, or a physical port of a file.

[0003]

On the other hand, the LSR interface in GMPLS is classified into four by switching capability, namely: PSC (Packet Switch Capable), TDM (Time-Division Multiplex Capable), LSC (Lambda Switch Capable) and FSC (Fiber Switch Capable). Moreover, the concept of labels in GMPLS is shown in FIG. 13.

[0004]

(Description of PSC)

A PSC interface can identify the border of an IP packet or a cell, and performs data transfer processing according to the contents of the IP packet header or cell header. In FIG. 13(a), in the packet layer, a label uniquely defined by each link is defined, and the label is given to the IP packet to form an LSP (Label Switch Path). The link in FIG.

13(a) is a link which is defined between LSRs in order to transfer the IP packet. If transferring the IP packet on SDH/SONET, it becomes a SDH/SONET path. If transferring on Ethernet (registered trademark), it becomes an Ethernet (registered trademark).

[0005]

(Description of TDM)

The TDM interface performs data transfer processing based on a periodically repeated time slot. In FIG. 13(b), in the TDM layer, the label becomes the time slot. An example of a TDM interface is a DXC (data cross-connect) interface, which connects the time slot allocated on the input side and the time slot allocated on the output side, to form a TDM path, that is a SDH/SONET path. The link may be a wavelength path in some cases, or may simply be a fiber in other cases.

[0006]

(Description of LSC)

An LSC interface performs data transmission processing based on the wavelength in the fiber used for transferring the data. In FIG. 13(c), in the Lambda layer, the label becomes the wavelength. An example of an LSC interface is an OXC (optical cross-connect) interface, which connects the wavelength allocated on the input side and the wavelength allocated on the output side to form a Lambda path. An OXC interface having LSC performs switching in wavelength units.

[0007]

(Description of FSC)

An FSC interface performs data transmission processing based on the position of an actual physical port of a fiber used for transferring the data. In FIG. 13(d), in the fiber layer, the label becomes the fiber. An example of an FSC interface is an OXC interface, which connects the input side fiber and the output side fiber to form a fiber path. The OXC interface having FSC performs switching in fiber units. The link means the physical aggregate of fibers, including conduits, etc.

[0008]

The above interfaces of switching capability can be hierarchized for use. For example, FSC, LSC, TDM and PSC in sequential order from the upper hierarchy. In GMPLS, the path with respect to the respective switching capability mentioned above is

also called LSP. FIG. 14 shows the hierarchical structure of LSP. PSC-LSP belongs to TDM-LSP, and the PSC-LSP link becomes TDM-LSP. TDM-LSP belongs to LSC-LSP, and the TDM-LSP link becomes LSC-LSP. LSC-LSP becomes FSC-LSP and the LSC-LSP link becomes FSC-LSP. Moreover, considering a case where the TDM layer is omitted, PSC-LSP belongs to LSC-LSP, and the PSC-LSP link becomes LSC-LSP. The relation of LSC-LSP and FSC-LSP is similar to that of FIG. 13(b). As the layer becomes lower, the LSP band becomes broader.

[0009]

[Non Patent Document 1]

E. Rosen, A. Viswanathan, and R. Callon, "Multiprotocol Label Switching Architecture", RFC 3031.

[Non Patent Document 2]

J. Moy, "OSPF Version 2", RFC 2328.

[Non Patent Document 3]

R. Coltun, "The OSPF Opaque LSA Option", RFC 2370.

[Non Patent Document 4]

K. Kompella and Y. Rekhter, "OSPF Extension in Support of Generalized MPLS", IETF draft, draft-ietf-ccamp-ospf-gmpls-extensions-09.txt, Dec. 2002.

[Non Patent Document 5]

P. Ashwood-Smith et al, "Generalized MPLS Signaling-RSVP-TE Extensions", IETF draft, draft-ietf-mpls-generalized-rsvp-te-09.txt, Aug. 2002.

[Non Patent Document 6]

D. Awduche et al., "RSVP-TE : Extensions to RSVP for LSP Tunnels", RFC 3209, December 2001.

[Non Patent Document 7]

A. Banerjee et al, "Generalized Multiprotocol Label Switching: An Overview of Routing and Management Enhancements", IEEE Commun. Mag., pp. 144-150, Jan. 2001.

[0010]

[Problem to be Solved by the Invention]

In such conventional techniques, for example as shown in FIG. 15, if GMPLS nodes 2, 3, 4, 5, and 6 being GMPLS nodes having PSC switching capability and LSC

switching capability, and IP/MPLS nodes 21 and 27 having only the PSC function are mixed, the IP/MPLS nodes are not matched with GMPLS protocol. Therefore, as shown in FIG. 16 in the conventional technique, all nodes have to be replaced by GMPLS nodes in order to match the IP/MPLS nodes having only PSC function with GMPLS protocol. Accordingly, the installation cost becomes higher for installing the GMPLS nodes.

[0011]

That is, as shown in FIG. 16, in such a conventional technique, all nodes have to be replaced by GMPLS nodes which are operated by GMPLS protocol in order to match the IP/MPLS nodes having only PSC function with GMPLS protocol.

[0012]

In GMPLS, there are routing protocols and signaling protocols for GMPLS with the extended IP/MPLS. In the routing protocol for GMPLS, GMPLS regards LSPs in all hierarchies as the link from the viewpoint of the upper layer, and advertise the link state. Accordingly, the nodes in the GMPLS network hold all link states, and have the topologies of the respective layers. A database of the topologies is made for traffic engineering, and is called a GMPLS-TED (Traffic Engineering Database). The respective nodes hold the GMPLS-TED.

[0013]

In the signaling protocol, there are signaling protocols for GMPLS, and all GMPLS nodes are required to operate the signaling protocol for GMPLS. FIG. 17 shows how LSC-LSPs are established on the hierarchy of PSC-LSP. The LSC-LSP is established between node 2 and node 4. The LSC-LSP is established between node 4 and node 5. The PSC-LSP is established through the two LSC-LSPs between node 1 and node 7. FIG. 18 shows the structure of a conventional GMPLS node.

[0014]

The present invention is based on such background, with an object of providing a network having MPLS and IP/MPLS mixed; a GMPLS edge node, and an IP/MPLS node which make the IP/MPLS node operate as is without replacing the IP/MPLS node with the GMPLS node, even if the GMPLS node and the IP/MPLS node are mixed.

[0015]

[Means for Solving the Problem]

In the technique of the present invention, it is not necessary to replace all nodes with GMPLS. The node which was originally the IP/MPLS node can be used as the IP/MPLS as is.

[0016]

A GMPLS cloud which is composed of only GMPLS nodes is constructed. A node in the GMPLS cloud which is connected to the IP/MPLS node by a physical link is called a GMPLS edge node. Moreover, a node except for the GMPLS edge nodes in the GMPLS cloud is called a GMPLS core node.

[0017]

The GMPLS edge node supports the following functions so as to match with the protocol of the IP/MPLS node outside of the GMPLS cloud. The PSC-LSP is established between the GMPLS edge routers. The PSC-LSP is used as the IP/MPLS link from the aspect of IP/MPLS node. The signaling of MPLS-LSP establishment requested from the IP/MPLS is operated. The GMPLS edge node has the GMPLS-TED and the IP/MPLS-TED. The IP/MPLS node has the IP/MPLS-TED. The GMPLS core node has the GMPLS-TED.

[0018]

Accordingly, the IP/MPLS node can be operated in a network having GMPLS mixed, in a similar way to that of a network having IP/MPLS only, without operating the GMPLS protocol.

[0019]

That is, a first aspect of the present invention is a GMPLS edge node which is used in a network in which a GMPLS network and an IP network are mixed, the GMPLS network comprising a GMPLS node, the IP network comprising an IP/MPLS node, and which constitutes the GMPLS network, and which is directly connected to the IP network.

[0020]

Here, the present invention is characterized by comprising: a device which establishes a GMPLS label path of a packet layer with another GMPLS edge node in the GMPLS network; and a device which tunnel transfers a packet transferred from the IP/MPLS node with the other GMPLS edge node through the GMPLS label path.

[0021]

Therefore, viewing from the IP/MPLS node, the GMPLS label path of the packet layer established in the GMPLS network looks like a label path in the IP/MPLS network. Accordingly, a network having the IP/MPLS and the GMPLS mixed can be configured.

[0022]

It is desirable to provide a device which advertises link state information of the GMPLS label path of the packet layer to the IP/MPLS node by a router LSA (Label Switching Advertisement) as a normal link in the IP/MPLS node.

[0023]

Therefore, the link state information of the GMPLS label path of the packet layer in the GMPLS network can be advertised in a form acceptable by the IP/MPLS node.

[0024]

It is desirable to provide: a device which holds the link state information having the GMPLS label path of the packet layer advertised as the link; and a device which holds link state information inside of the GMPLS network.

[0025]

Therefore, the link state information of both the GMPLS network and the IP/MPLS network can be held to deal with both networks.

[0026]

There may be provided a device which converts a link of PSC-LSP (Packet Switch Capable-Label Switch Path) used for IP/MPLS from an unnumbered system into a numbered system to advertise as the link of the numbered system. Alternatively, there may be provided a device which advertises the GMPLS label switch path of the packet layer as a link of a numbered system.

[0027]

Therefore, the link state information of the GMPLS label path of the packet layer in the GMPLS network can be advertised in a form acceptable by the IP/MPLS node.

[0028]

There may be provided: a device which performs processing inside of the GMPLS network in accordance with an unnumbered system; and a device which

converts a link of PSC-LSP used for IP/MPLS from the unnumbered system into a numbered system to advertise as the link of the numbered system. Alternatively, there may be provided: a device which performs processing inside of the GMPLS network in accordance with an unnumbered system; and a device which converts the GMPLS label switch path of the packet layer from the unnumbered system into a numbered system to advertise as the link of the numbered system.

[0029]

Therefore, convenient processes may be respectively performed in the GMPLS network and the IP/MPLS network.

[0030]

In such a numbered system, there may be provided: a device which previously stores an IP address; and a device which uses the stored IP address as an IP address of the link of the numbered system.

[0031]

A second aspect of the present invention is an IP/MPLS node which is used in a network in which a GMPLS network and an IP network are mixed, the GMPLS network comprising a GMPLS node, the IP network comprising an IP/MPLS node, and which is connected to the GMPLS network.

[0032]

Here, the present invention is characterized in that a GMPLS edge node which constitutes the GMPLS network and which is directly connected to the IP network establishes a GMPLS label path of a packet layer with another GMPLS edge node in the GMPLS network, and comprises a device which holds link state information having a GMPLS label path of the packet layer advertised as a link.

[0033]

A third aspect of the present invention is a network which is characterized by comprising a GMPLS edge node and an IP/MPLS node according to the present invention wherein the GMPLS and the IP/MPLS are mixed.

[0034]

A fourth aspect of the present invention is a packet communication method in a network in which a GMPLS network and an IP network are mixed, the GMPLS network comprising a GMPLS node, the IP network comprising an IP/MPLS node, and the

IP/MPLS node transfers a packet with the GMPLS node.

[0035]

Here, the present invention is characterized by comprising: a step of providing a GMPLS edge node which is directly connected to the IP network among GMPLS nodes constituting the GMPLS network; a step of establishing a GMPLS label path of a packet layer with another GMPLS edge node in the GMPLS network by the GMPLS edge node; and a step of tunnel transferring a packet transferred from the IP/MPLS node with the other GMPLS edge node through the GMPLS label path.

[0036]

Link state information of the GMPLS label path of the packet layer may be advertised to the IP/MPLS node by a router LSA as a normal link in the IP/MPLS node.

[0037]

Link state information having the GMPLS label path of the packet layer advertised as the link may be held, and link state information inside of the GMPLS network may be held.

[0038]

A link of PSC-LSP used for IP/MPLS may be converted from an unnumbered system into a numbered system and be advertised as the link of the numbered system.

[0039]

The GMPLS network may perform processing in accordance with an unnumbered system, and a link of PSC-LSP used for IP/MPLS may be converted from the unnumbered system into a numbered system and be advertised as the link of the numbered system.

[0040]

The GMPLS label switch path of the packet layer may be advertised as the link of a numbered system.

[0041]

The GMPLS network may perform processing in accordance with an unnumbered system, and the GMPLS label switch path of the packet layer may be converted from the unnumbered system into a numbered system, and be advertised as the link of the numbered system.

[0042]

An IP address may be previously stored, and the stored IP address may be used as an IP address of the link of the numbered system.

[0043]

The IP/MPLS node may hold link state information having the GMPLS label path of the packet layer advertised as a link.

[0044]

A fifth aspect of the present invention is a network configuring method which is characterized by configuring a network in which GMPLS and IP/MPLS are mixed, the method comprises the steps of: providing a GMPLS node which transfers a packet using the packet communication method of the present invention; and providing an IP/MPLS node which transfers the packet using the packet communication method of the present invention.

[0045]

[Embodiments of the Invention]

Hereunder is a description of GMPLS edge nodes, GMPLS core nodes, IP/MPLS nodes, networks, and a method for configuring a network, of an embodiment of the present invention, with reference to the drawings.

[0046]

In the network of the embodiment of the present invention, as shown in FIG. 1, an IP packet transferred from an IP/MPLS node is transferred in accordance with tunnel transfer using an MPLS-LSP (FIG. 1(a)) or a PSC-LSP (FIG. 1(b)), that is a GMPLS label path of a packet layer established between a GMPLS edge node 2 and a GMPLS edge node 5. In the embodiment of the present invention, the description is only regarding one-way, to make the description easily understood. However, the transferring direction may be either two-way or one-way. The description of two-way is omitted since it can be easily deduced from the description of one-way.

[0047]

A packet communication protocol in the network of the embodiment of the present invention is described with reference to FIG. 2. The GMPLS node detects the link to be connected to the GMPLS node itself (Step 1). The link with an IP/MPLS node is established (Step 2). Then, the GMPLS node recognize itself as the GMPLS edge node and sets the mode (Step 3). Subsequently, the GMPLS label path of the

packet layer is established with another GMPLS edge node in the GMPLS network (Step 4). When the establishment of the GMPLS label path of the packet layer is completed, the packet transferred from the IP/MPLS node is tunnel transferred to the other GMPLS edge nodes (Step 5).

[0048]

As shown in FIG. 3, the GMPLS edge nodes of the embodiment of the present invention are used in the network in which a GMPLS network and an IP network are mixed and the GMPLS network comprises GMPLS nodes and the IP network comprises IP/MPLS nodes, and the GMPLS edge nodes constitute the GMPLS network and are directly connected to the IP network.

[0049]

Here, as shown in FIG. 4, a feature of the embodiment of the present invention is that there is provided a GMPLS signaling unit 10 which establishes the GMPLS label path of the packet layer with another GMPLS edge node in the GMPLS network, and a GMPLS routing unit 11 which tunnel transfers the packet transferred from the IP/MPLS node with the other GMPLS edge node through the GMPLS label path.

[0050]

Furthermore, there is provided an IP/MPLS-TED unit 13 which takes the GMPLS label path of the packet layer as a normal link in the IP/MPLS node and advertises the link state information to the IP/MPLS node by a router LSA. The IP/MPLS-TED unit 13 holds the link state information advertised by using the GMPLS label path of the packet layer as the link. Furthermore, it comprises a GMPLS-TED unit 14 which holds the link state information inside of the GMPLS network.

[0051]

Moreover, as shown in FIG. 10, with respect to the PSC-LSP link used for IP/MPLS, there is provided an IP address pool 16 which converts an unnumbered system into a numbered system to advertise as the link of the numbered system. Alternatively, as shown in FIG. 11, the GMPLS network processes in accordance with the unnumbered system, and, there is provided an IP address pool 16 and a numbered/unnumbered converting unit 15 which converts the unnumbered system into the numbered system to advertise as the link of the numbered system with respect to the PSC-LSP link used for IP/MPLS. The numbered/unnumbered converting unit 15 can advertise the GMPLS

label switch path of the packet layer as the link of the numbered system.

[0052]

Alternatively, it is also acceptable that the GMPLS network processes in accordance with the unnumbered system, and the numbered/unnumbered converting unit 15 and the IP address pool 16 are used to convert the GMPLS label switch path of the packet layer of the unnumbered system into a numbered system and advertise as the link of the numbered system.

[0053]

The IP address pool 16 previously stores the IP address, and the stored IP address is used as the IP address of the link of the numbered system.

[0054]

Moreover, the GMPLS edge node also includes an MPLS signaling unit 17 and an IP/MPLS routing unit 18 as the function of the IP/MPLS node.

[0055]

As shown in FIG. 6, the IP/MPLS edge node of the embodiment of the present invention comprises the IP/MPLS-TED unit 13 which holds the link state information advertised using the GMPLS label path of the packet layer as the link.

[0056]

A switch unit 19 switches the paths which are established to the respective nodes.

[0057]

The network of the embodiment of the present invention includes the GMPLS edge node and the IP/MPLS node of the embodiment of the present invention, wherein GMPLS and IP/MPLS are mixed.

[0058]

Hereunder is a detailed description of the embodiment of the present invention.

[0059]

[Embodiment 1]

The establishment condition of the LSP establishment in Embodiment 1 is described using FIG. 1. The GMPLS edge node 2 and the GMPLS edge node 5 establish the PSC-LSP. Since the PSC-LSP is established through the LSC-LSP, the LSC-LSP is established before the PSC-LSP is established. The GMPLS edge node is

used as a normal link of IP/MPLS with respect to the IP/MPLS node outside of the GMPLS cloud.

[0060]

As shown in FIG. 1(a), if an MPLS-LSP is established to an IP/MPLS node 1 and an IP/MPLS node 7, the MPLS-LSP uses the PSC-LSP as a normal link with respect to the IP/MPLS node. The IP packet passes inside the MPLS-LSP.

[0061]

Moreover, as shown in FIG. 1(b), in some cases the IP/MPLS node 1 transfers the IP packet to the IP/MPLS node 7 and not through the MPLS LSP. In this case, the PSC-LSP established to the GMPLS edge node 2 and the GMPLS edge node 5 is used as a normal link for the IP/MPLS node.

[0062]

FIG. 3 shows the management condition of the link state information in the network comprising the IP/MPLS node and the GMPLS node. The GMPLS node in the GMPLS cloud manages the link state information of the GMPLS. For example, if the link state information is advertised in the GMPLS using the routing protocol for the GMPLS, an Opaque LSA is used (for example, refer to Non Patent Documents 2, 3, and 4). Advertisement is performed in the same form as that of the link between the IP/MPLS nodes, so that the PSC-LSP established between the GMPLS edge nodes is treated as a normal link for the IP/MPLS router. For example, if OSPF routing protocol is used, the router LSA is used (for example, refer to Non Patent Document 2).

[0063]

As shown in FIG. 4, FIG. 10, and FIG. 11, the GMPLS edge node has the GMPLS-TED unit 14 and the IP/MPLS-TED unit 13. As shown in FIG. 6, the IP/MPLS node has the IP/MPLS-TED unit 13. As shown in FIG. 5, the GMPLS core node has the GMPLS-TED unit 14. In the IP/MPLS node, the PSC-LSC in the GMPLS cloud is treated as a normal link between the IP/MPLSs. The link state which is advertised by the GMPLS routing protocol is not advertised to the IP/MPLS node.

[0064]

FIG. 4 shows the structure of a control unit of the GMPLS edge node. The control unit of the GMPLS edge node comprises; an MPLS signaling unit 17, a GMPLS signaling unit 10, an IP/MPLS routing unit 18, a GMPLS routing unit 11, an

IP/MPLS-TED unit 13, and a GMPLS-TED unit 14. They are controlled by a control unit controller 20. The GMPLS signaling unit 10 is operated for example by a GMPLS-RSVP-TE protocol (for example, refer to Non Patent Document 5). The MPLS signaling unit 17 is operated for example by an RSVP-TE protocol (for example, refer to Non Patent Document 6).

[0065]

FIG. 5 shows the structure of a control unit of the GMPLS core node. The control unit of the GMPLS core node comprises a GMPLS signaling unit 10, a GMPLS routing unit 11, and a GMPLS-TED unit 14. They are controlled by a control unit controller 20. The GMPLS core node is not necessarily matched with the IP/MPLS protocol.

[0066]

FIG. 6 shows the structure of a control unit of the IP/MPLS node. The control unit of the IP/MPLS node comprises an MPLS signaling unit 17, an IP/MPLS routing unit 18, and an IP/MPLS-TED unit 13. They are controlled by a control unit controller 20. The IP/MPLS node is not necessarily matched with the GMPLS protocol.

[0067]

The IP/MPLS node can be operated without considering the GMPLS protocol. In the IP/MPLS node, traffic engineering can be performed without considering the GMPLS protocol. On the other hand, in the GMPLS cloud, traffic engineering can be performed by the GMPLS protocol.

[0068]

[Embodiment 2]

In the case of realizing a link interface, there is a numbered system expressed by allocating the IP address, and an unnumbered system expressed by the combination of the IP address being the node identifier and the link identifier which is uniquely allocated in the node. A link expressed using the numbered system is called a numbered link, and a link expressed using the unnumbered system is called an unnumbered link (for example, refer to Non Patent Document 7).

[0069]

Hereunder is a description of the unnumbered link. The IP address is normally allocated to the link interface in the MPLS network. The link in the network can be

identified by the IP address. However, the GMPLS has a capacity of 100 or more wavelengths per fiber. If the IP addresses are allocated to the respective wavelength interfaces, the number of required IP addresses becomes enormous. Moreover, the LSPs of the respective layers are advertised as a TE link with respect to the upper layer so that, if the IP addresses are allocated with respect to the respective TE links, there is concern of a shortage of resources for the IP address.

[0070]

In view of the above, in the GMPLS, in order to identify the link (hereunder, TE link is simply called link in some cases), the link identifier which is allocated to the link interface is introduced. Although it is required to globally allocate the IP address, it is applicable as long as the link identifier is unique in the respective routers. The link in the network can be identified by the combination of (node identifier, link identifier).

[0071]

A link expressed by the combination of (node identifier, link identifier) is called an unnumbered link. Unnumbered means that the IP address is not allocated to the link interface. Therefore, in GMPLS, even if the number of wavelengths is increased or the number of TE links is increased, the problem of shortages of IP addresses is solved.

[0072]

Due to such reasons, the unnumbered system is normally used in the GMPLS cloud. However, in the case where the IP/MPLS node treats only the numbered link and can not treat the unnumbered link, if the PSC LSC is established between the GMPLS edge nodes, it is necessary to make the PSC LSC the unnumbered link.

[0073]

An example of a numbered link and an unnumbered link is shown in FIG. 7. As shown in FIG. 7(a), for the GMPLS node in the GMPLS cloud, the links of the respective layers are the unnumbered links except for the PSC LSC. The PSC LSC is established as the numbered link. As shown in FIG. 7(b), for the IP/MPLS node outside of the GMPLS cloud, in the case of the PSC-LSC, the numbered link used within the GMPLS cloud is used.

[0074]

An example of a numbered link and an unnumbered link is shown in FIG. 8. As shown in FIG. 8(a), for the GMPLS node in the GMPLS cloud, the links of all the

layers in the GMPLS cloud are the unnumbered links. As shown in FIG. 8(b), for the IP/MPLS node outside of the GMPLS cloud, in the case of the PSC-LSC, the numbered link used within the GMPLS cloud is converted into the unnumbered link and used.

[0075]

In this way, even in the case where the IP/MPLS node treats only the numbered link, the IP/MPLS node can be operated without considering the GMPLS protocol, by establishing the PSC-LSC as the numbered link.

[0076]

[Embodiment 3]

In the case where the PSC-LSC is treated as the numbered link, the IP address is required to be allocated to the interface of this link in the GMPLS edge node. The value of the IP address must be allocated uniquely inside the network. The IP address allocated to the PSC-LSC interface of the respective nodes should not be overlapped.

[0077]

As shown in FIG. 9, assuming that the PSC-LSC is dynamically established, the respective GMPLS edge nodes previously store the IP address which can be allocated by its own node, in the IP address pool 16. The IP address stored in the IP address pool 16 is the unique value in the network. If the PSC-LSC is established, the respective nodes select one IP address to be allocated to the link from the IP address pool 16, and obtain it as the IP address of the link of this interface. The operation is performed on the opposite ends of the GMPLS edge node. The IP address obtained by its own node is notified by a message to the opposite GMPLS edge node.

[0078]

FIG. 10 shows the structure of a GMPLS edge node which has an IP address pool 16. The structure in FIG. 10 corresponds to the establishment example in FIG. 7. That is, in the establishment example in FIG. 7, as shown in FIG. 7(a), the PSC-LSC is identified by the numbered system, even in the GMPLS cloud. FIG. 11 shows the structure of a GMPLS edge node which has an IP address pool 16 and a numbered/unnumbered converting unit 17. The structure in FIG. 11 corresponds to the establishment example in FIG. 8. That is, in the establishment example in FIG. 8, as shown in FIG. 8(a), the numbered/unnumbered converting unit 17 can be used so as to completely apply an unnumbered system, in the GMPLS cloud.

[0079]

In this manner, even if the PSC-LSC is dynamically established, by previously storing the IP address in the IP address pool 16, the IP address of the link can also be dynamically allocated.

[0080]

[Effects of the Invention]

As described above, according to the present invention, it becomes possible to provide a network having MPLS and IP/MPLS mixed; a GMPLS edge node; and an IP/MPLS node which make the IP/MPLS node operate as is without replacing the IP/MPLS node with a GMPLS node, even if the GMPLS node and IP/MPLS node are mixed.

[Brief Description of the Drawings]

[FIG. 1] A conceptual diagram of tunnel transfer in an embodiment of the present invention.

[FIG. 2] A flowchart showing a packet communication protocol of the embodiment of the present invention.

[FIG. 3] A diagram showing a network comprising IP/MPLS nodes and GMPLS nodes of the embodiment of the present invention.

[FIG. 4] A block diagram of a control unit of a GMPLS edge node of the embodiment of the present invention.

[FIG. 5] A block diagram of a control unit of a GMPLS core node of the embodiment of the present invention.

[FIG. 6] A block diagram of a control unit of an IP/MPLS node of the embodiment of the present invention.

[FIG. 7] A diagram showing a numbered system in a GMPLS cloud and a numbered system outside of a GMPLS cloud.

[FIG. 8] A diagram showing a numbered system in a GMPLS cloud and a numbered system outside of a GMPLS cloud.

[FIG. 9] An explanatory diagram of the allocation of IP addresses to a numbered link of the embodiment of the present invention.

[FIG. 10] A block diagram of a control unit of a GMPLS edge node of the embodiment of the present invention.

[FIG. 11] A block diagram of a control unit of a GMPLS edge node of the embodiment of the present invention.

[FIG. 12] A diagram showing a network comprising IP/MPLS nodes.

[FIG. 13] A diagram showing the concept of labels.

[FIG. 14] An explanatory diagram of LSP hierarchization.

[FIG. 15] An explanatory diagram of the case where GMPLS nodes are inserted in a network comprising IP/MPLS nodes.

[FIG. 16] A diagram showing a conventional network comprising GMPLS nodes.

[FIG. 17] A diagram showing LSP hierarchization in the conventional network comprising GMPLS nodes.

[FIG. 18] A block diagram of a control unit for the conventional GMPLS node.

[Description of the Reference Symbols]

1, 7 IP/MPLS node

2, 5, 21, 27 GMPLS edge node

4 GMPLS core node

10 GMPLS signaling unit

11 GMPLS routing unit

13 IP/MPLS-TED unit

14 GMPLS-TED unit

15 numbered/unnumbered converting unit

16 IP address pool

17 MPLS signaling unit

18 IP/MPLS routing unit

19 Switch unit

20 Control unit controller

[Title of the Document] ABSTRACT

[Abstract]

[Problem] A network having MPLS and IP/MPLS mixed; a GMPLS edge node; and an IP/MPLS node are provided which make the IP/MPLS node operate as is without replacing the IP/MPLS node with a GMPLS node, even if the GMPLS node and the IP/MPLS node are mixed.

[Means for Solving the Problem] To match with the protocol of the IP/MPLS node outside of a GMPLS cloud, the GMPLS edge node establishes a PSC-LSP between GMPLS edge routers uses the PSC-LSP as an IP/MPLS link from the viewpoint of the IP/MPLS node, and operates signaling of an MPLS-LSP establishment requested from the IP/MPLS.

[Elected Drawing] FIG. 1

FIG.1

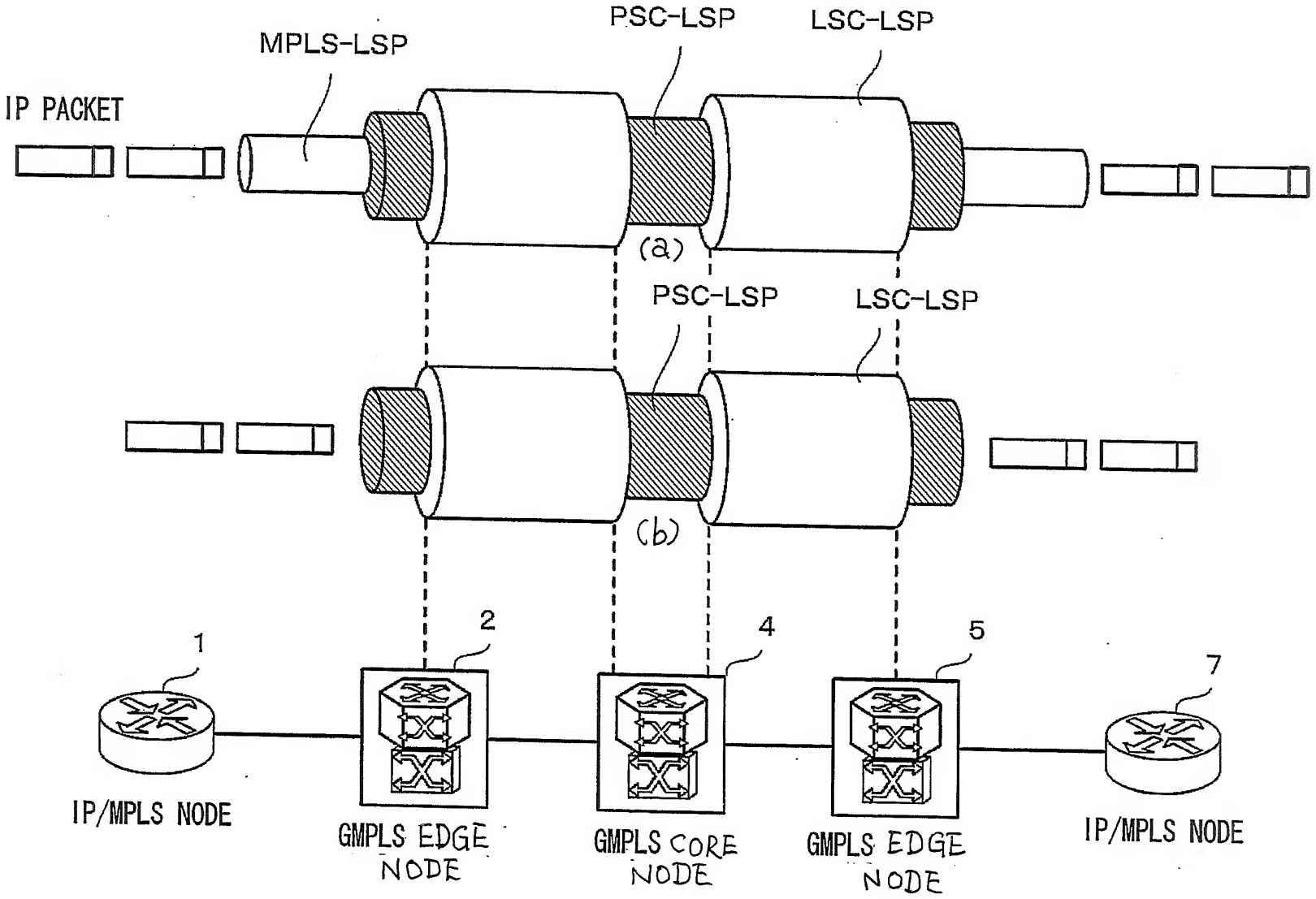

MPLS-LSP
PSC-LSP
LSC-LSP
IP PACKET
(a)
PSC-LSP
LSC-LSP
(b)
1
2
4
5
7
IP/MPLS NODE
GMPLS EDGE NODE
GMPLS CORE NODE
GMPLS EDGE NODE
IP/MPLS NODE

FIG.2

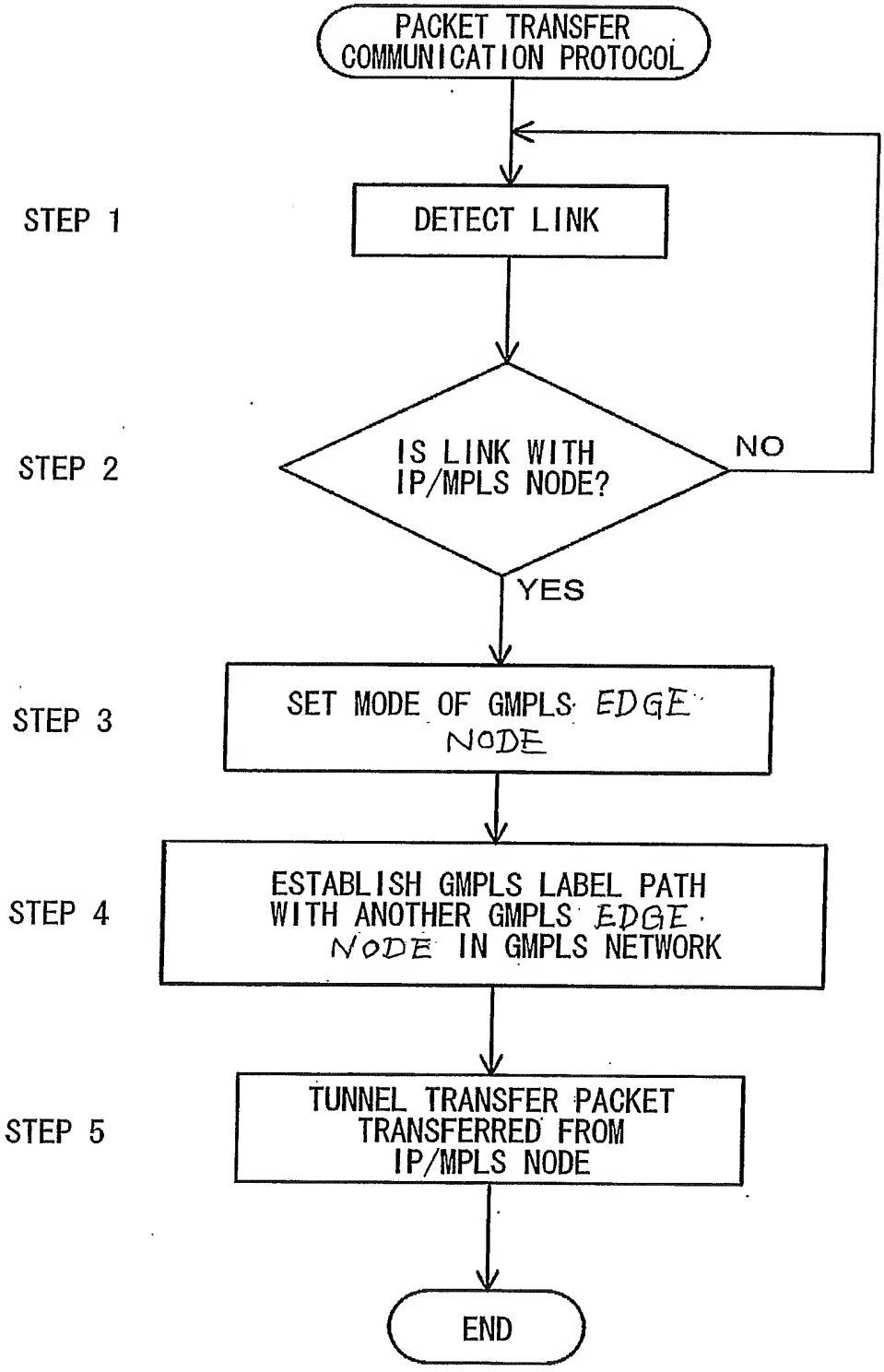

PACKET TRANSFER COMMUNICATION PROTOCOL
STEP 1
DETECT LINK
STEP 2
IS LINK WITH IP/MPLS NODE?
NO
YES
STEP 3
SET MODE OF GMPLS EDGE NODE
STEP 4
ESTABLISH GMPLS LABEL PATH WITH ANOTHER GMPLS EDGE NODE IN GMPLS NETWORK
STEP 5
TUNNEL TRANSFER PACKET TRANSFERRED FROM IP/MPLS NODE
END

FIG.3

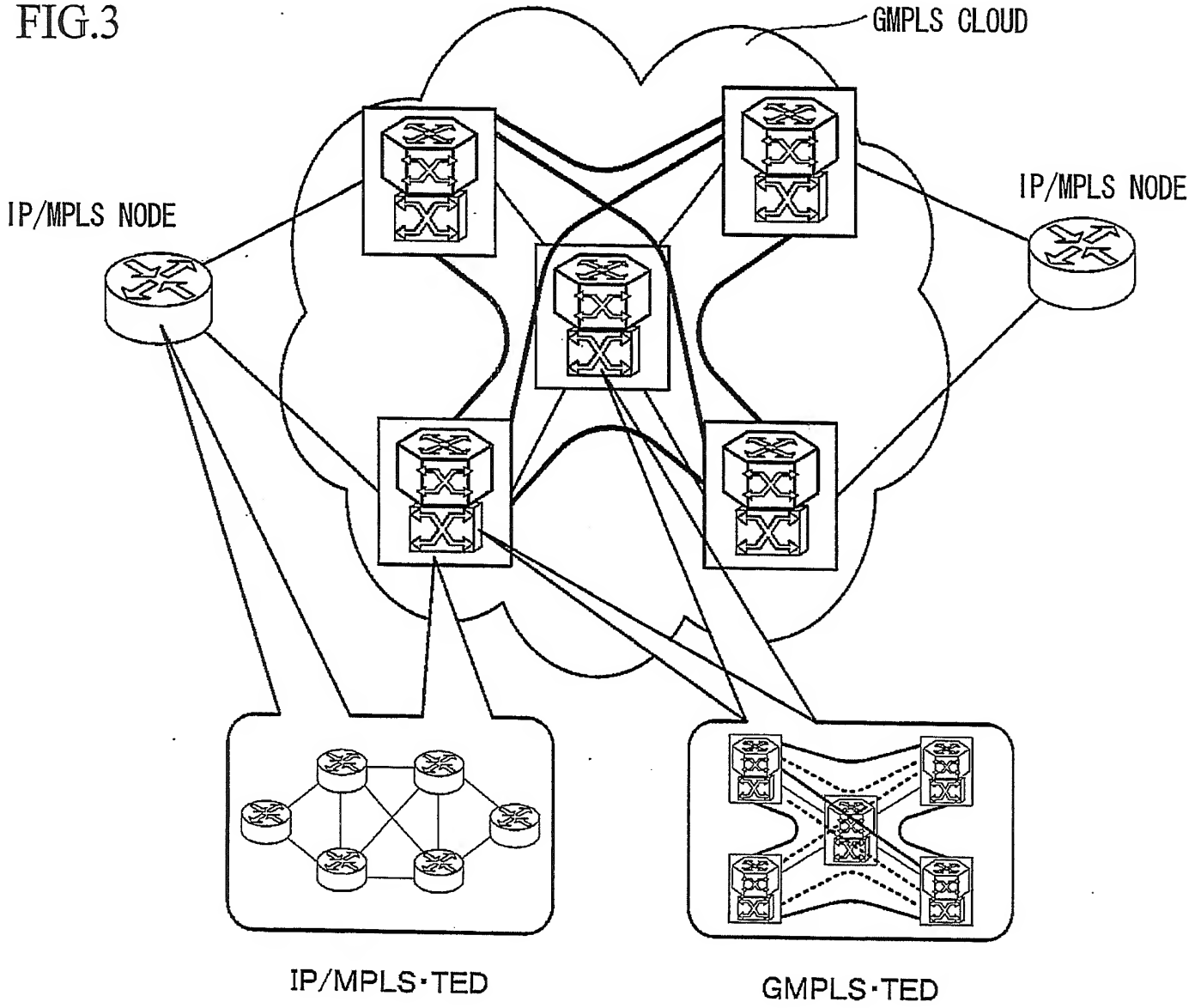


FIG.4

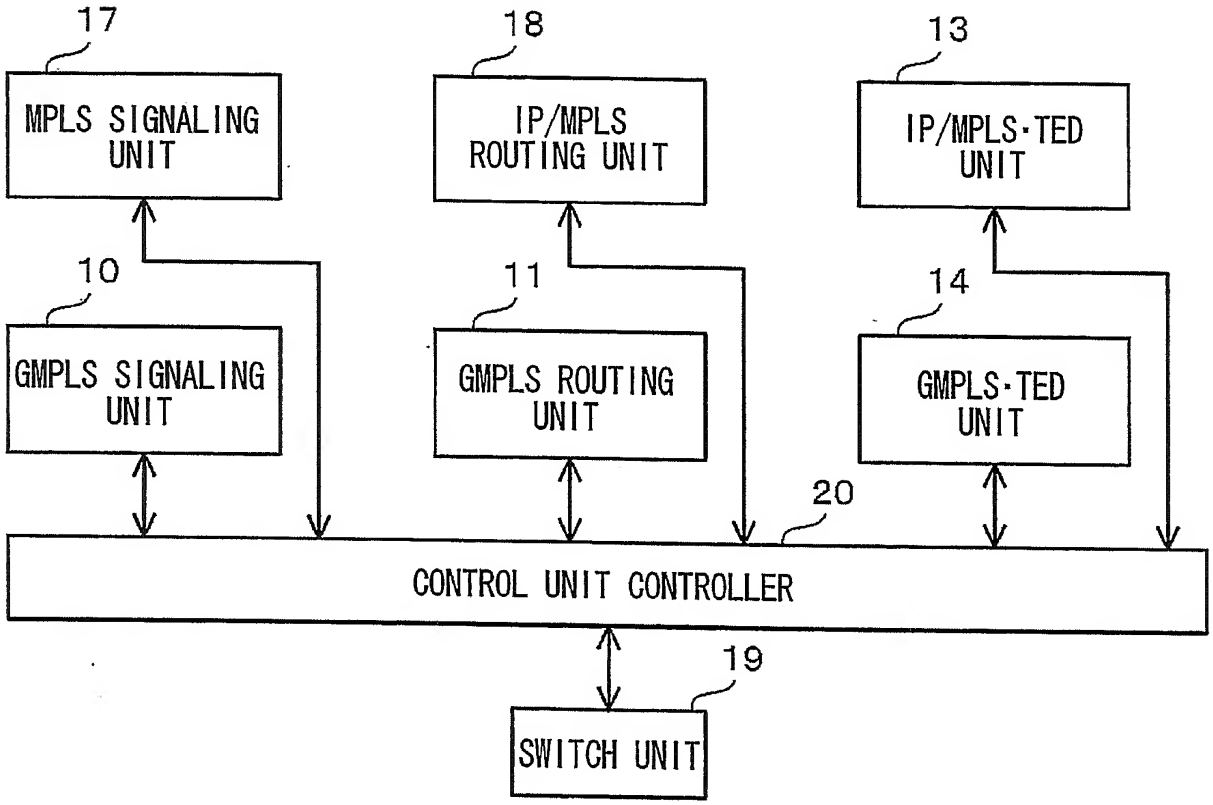

17
MPLS SIGNALING UNIT
18
IP/MPLS ROUTING UNIT
13
IP/MPLS·TED UNIT
10
GMPLS SIGNALING UNIT
11
GMPLS ROUTING UNIT
14
GMPLS·TED UNIT
20
CONTROL UNIT CONTROLLER
19
SWITCH UNIT

FIG.5

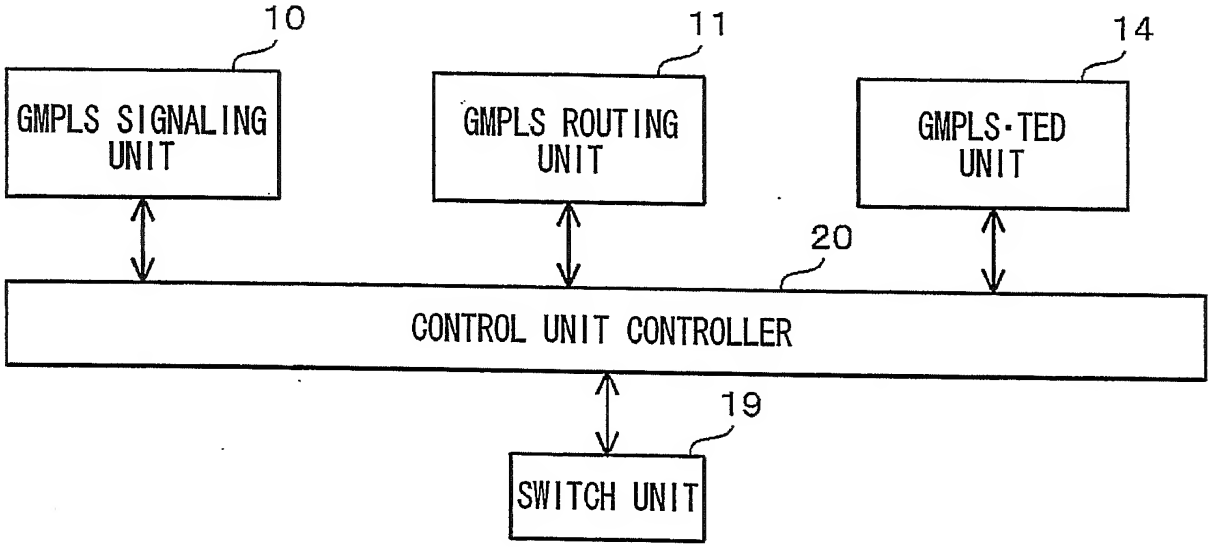

10
11
14
GMPLS SIGNALING UNIT
GMPLS ROUTING UNIT
GMPLS-TED UNIT
20
CONTROL UNIT CONTROLLER
19
SWITCH UNIT

FIG.6

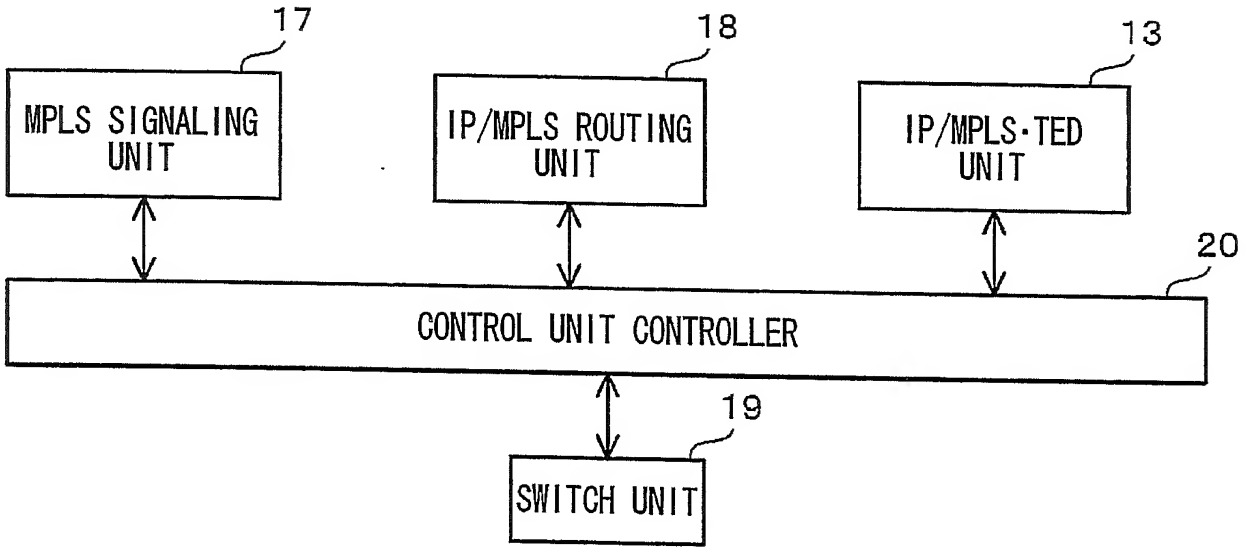
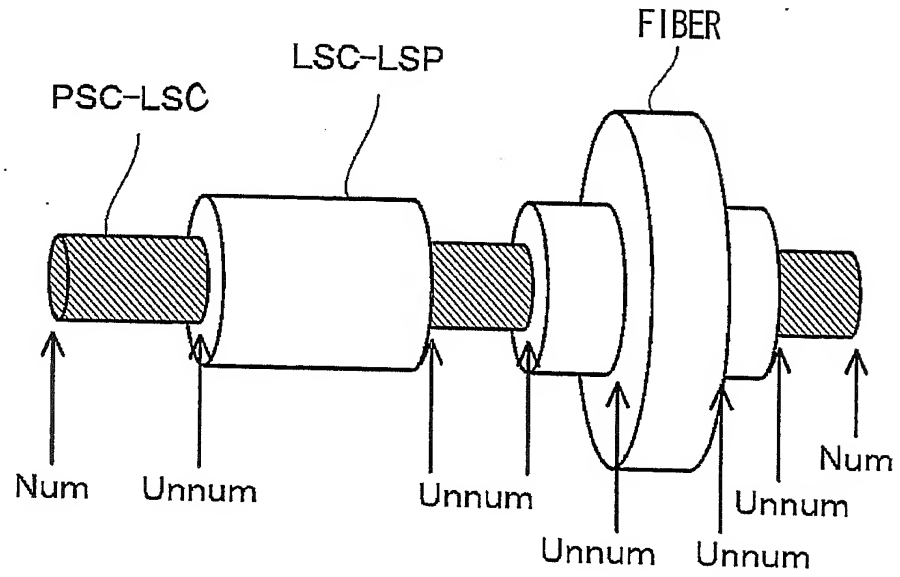
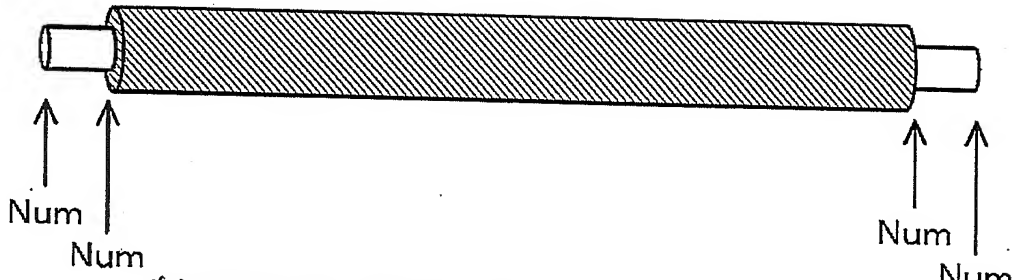

17
MPLS SIGNALING UNIT
18
IP/MPLS ROUTING UNIT
13
IP/MPLS·TED UNIT
20
CONTROL UNIT CONTROLLER
19
SWITCH UNIT

FIG.7



(a) NUMBERED SYSTEM IN GMPLS CLOUD

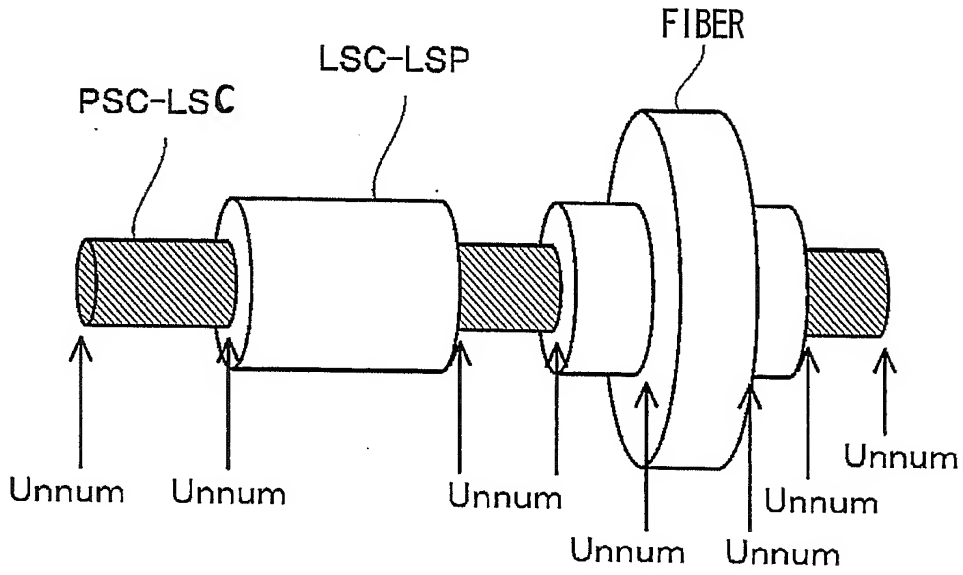


(b) NUMBERED SYSTEM OUTSIDE OF GMPLS CLOUD

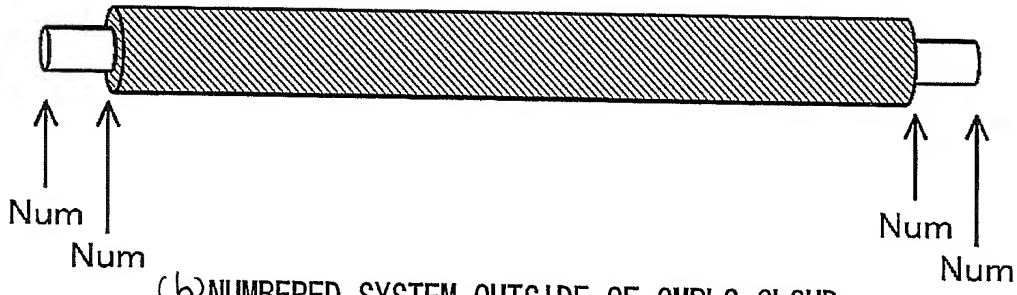
Num: numbered

Unnum: unnumbered

FIG.8



(a)NUMBERED SYSTEM IN GMPLS CLOUD



(b)NUMBERED SYSTEM OUTSIDE OF GMPLS CLOUD

Num:numbered

Unnum:unnumbered

FIG.9

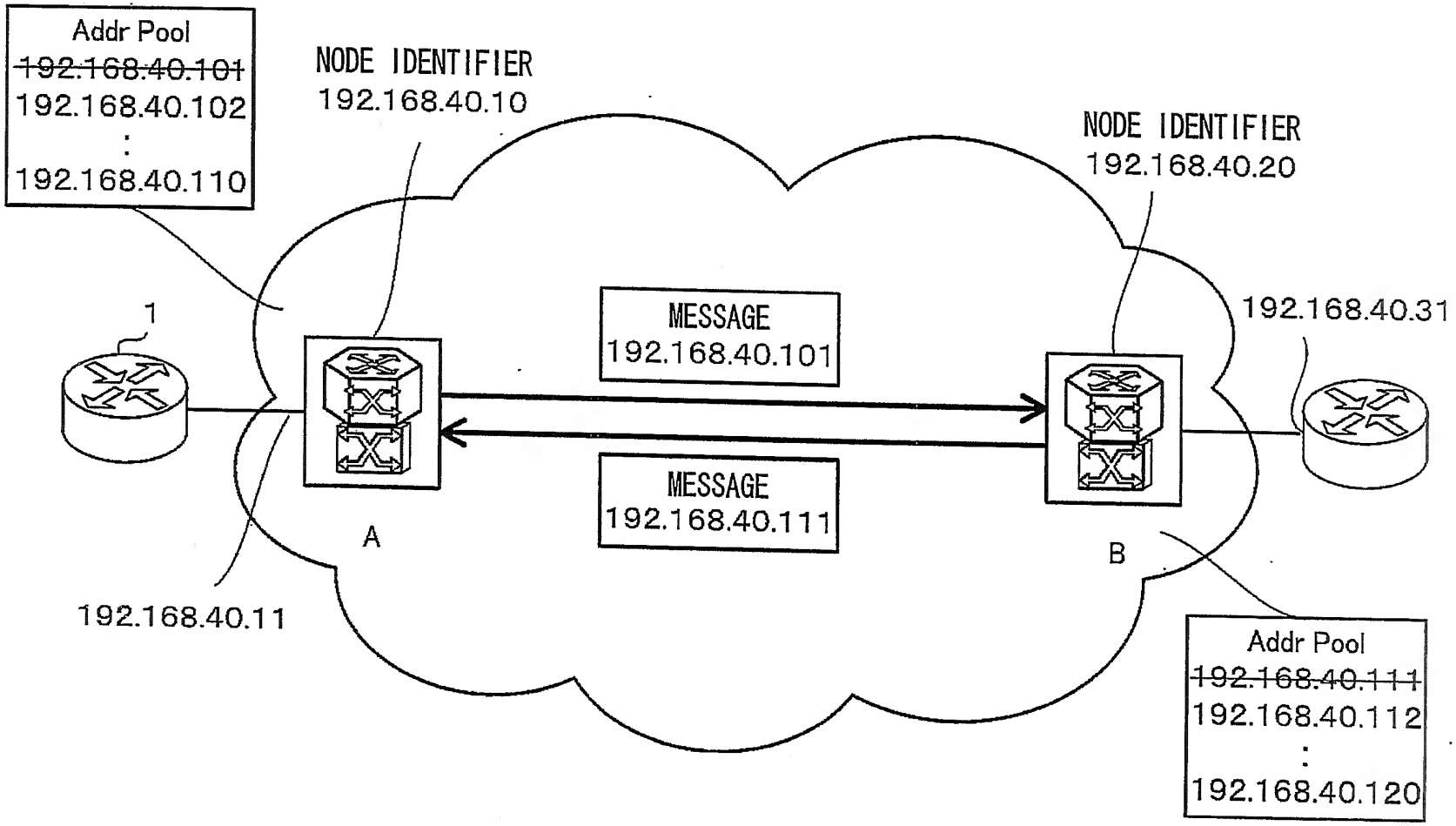

Addr Pool
~~192.168.40.101~~
192.168.40.102
:
192.168.40.110
NODE IDENTIFIER
192.168.40.10
NODE IDENTIFIER
192.168.40.20
1
MESSAGE
192.168.40.101
192.168.40.31
MESSAGE
192.168.40.111
A
B
192.168.40.11
Addr Pool
~~192.168.40.111~~
192.168.40.112
:
192.168.40.120

FIG.10

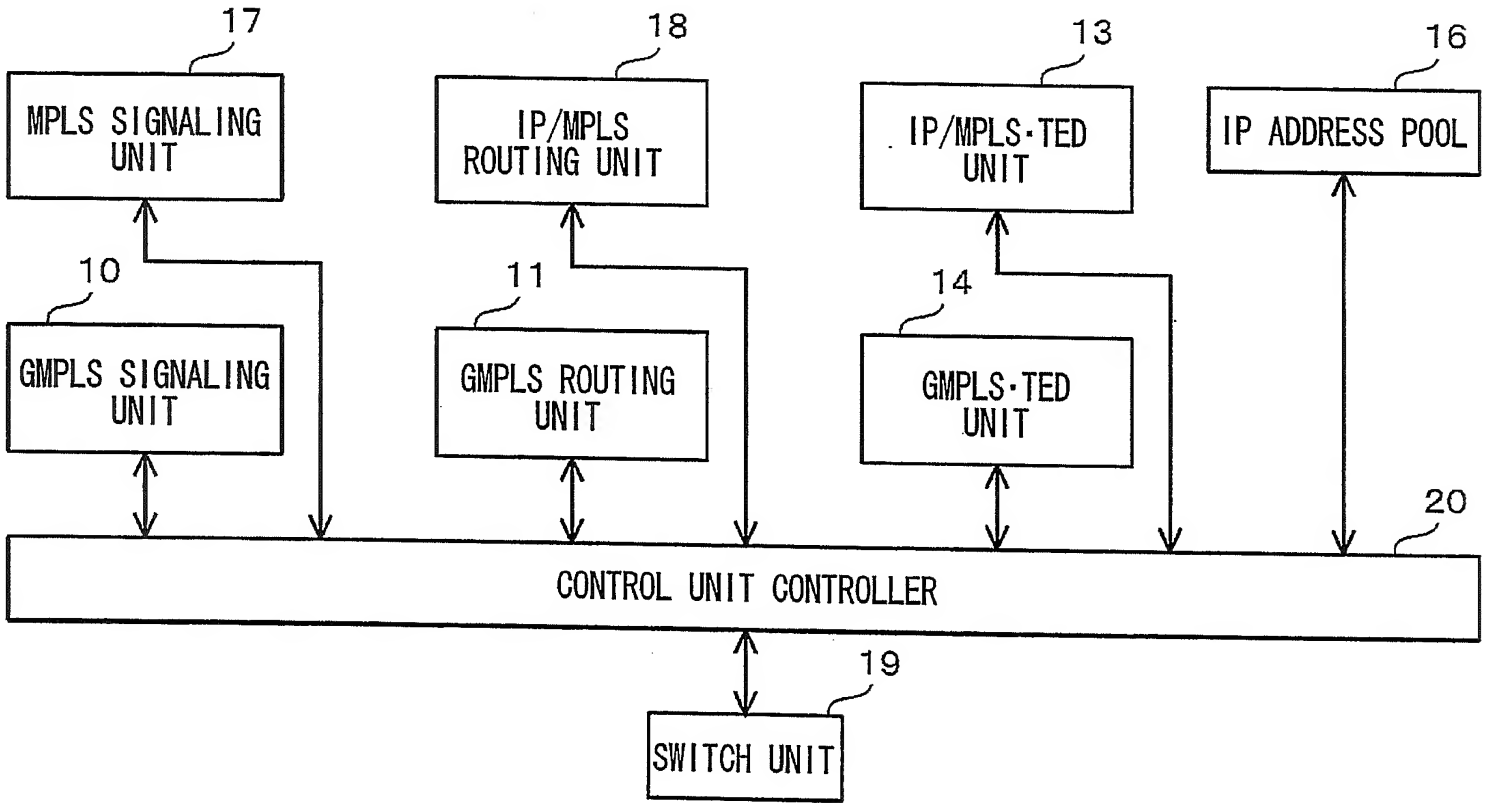

17
MPLS SIGNALING UNIT
18
IP/MPLS ROUTING UNIT
13
IP/MPLS·TED UNIT
16
IP ADDRESS POOL
10
GMPLS SIGNALING UNIT
11
GMPLS ROUTING UNIT
14
GMPLS·TED UNIT
20
CONTROL UNIT CONTROLLER
19
SWITCH UNIT

FIG.11

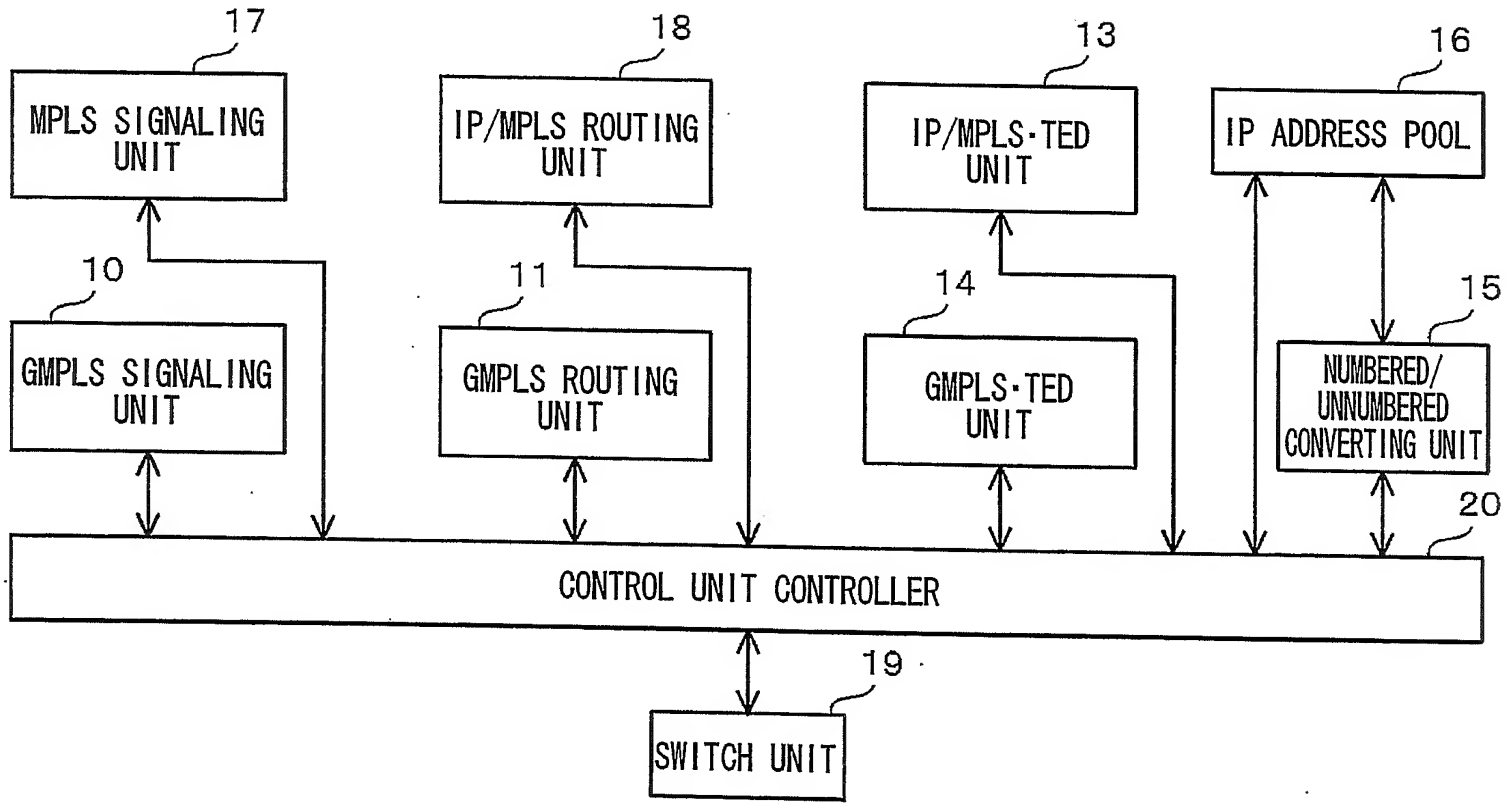

17
MPLS SIGNALING UNIT
18
IP/MPLS ROUTING UNIT
13
IP/MPLS-TED UNIT
16
IP ADDRESS POOL
10
GMPLS SIGNALING UNIT
11
GMPLS ROUTING UNIT
14
GMPLS-TED UNIT
15
NUMBERED/ UNNUMBERED CONVERTING UNIT
20
CONTROL UNIT CONTROLLER
19
SWITCH UNIT

FIG.12

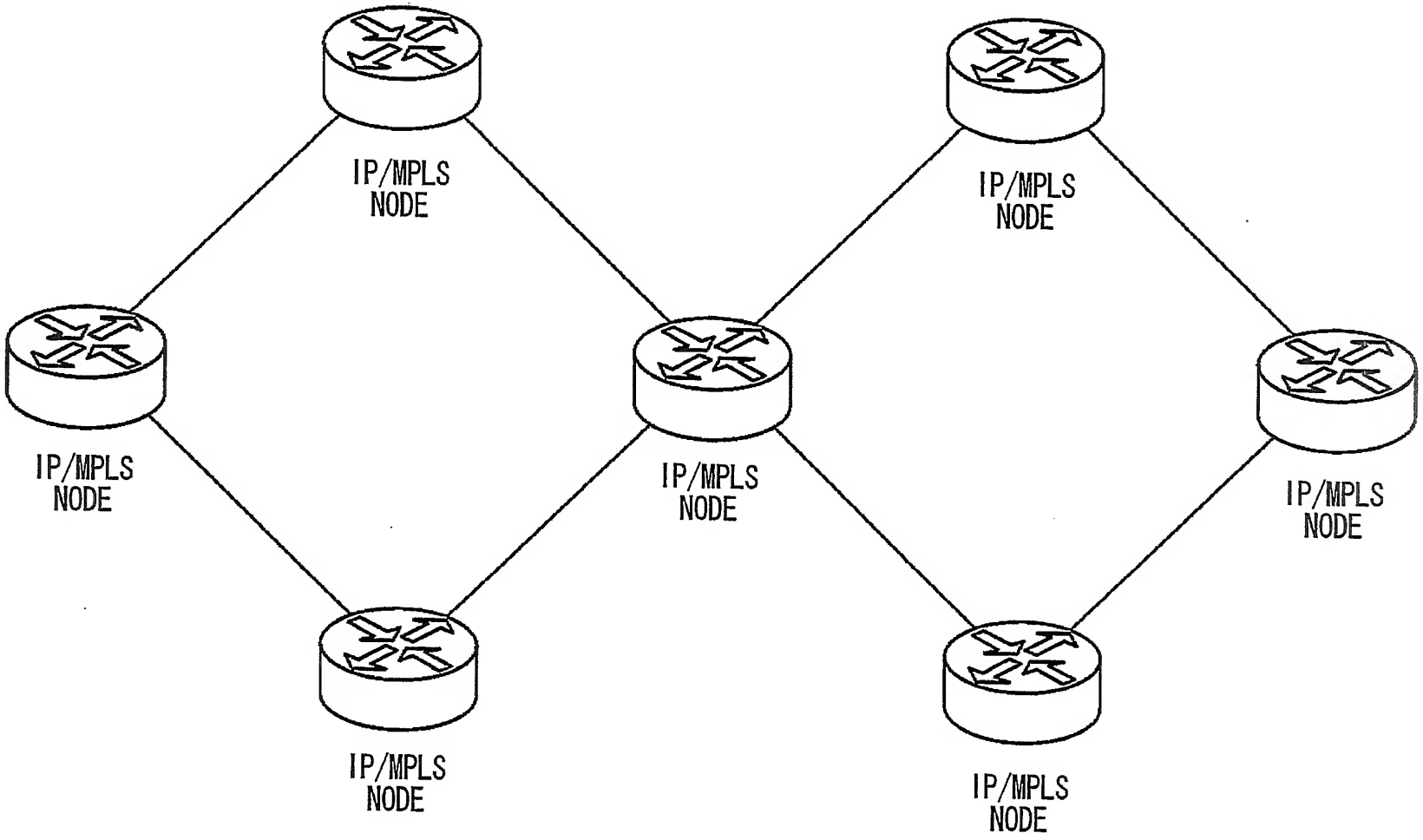

IP/MPLS NODE
IP/MPLS NODE
IP/MPLS NODE
IP/MPLS NODE
IP/MPLS NODE
IP/MPLS NODE
IP/MPLS NODE

FIG. 13

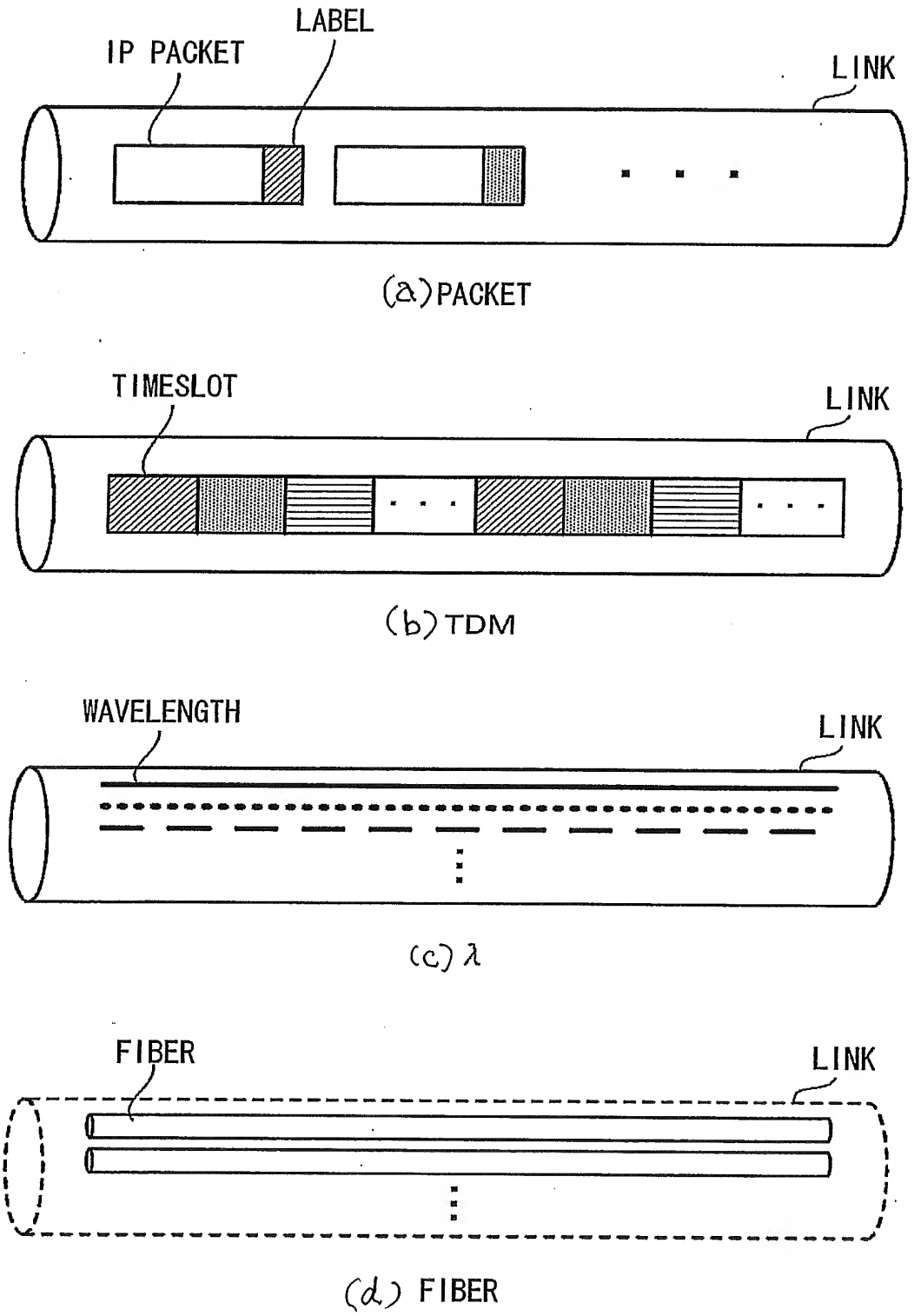

LABEL
IP PACKET
LINK
(a) PACKET
TIMESLOT
LINK
(b) TDM
WAVELENGTH
LINK
(c) λ
FIBER
LINK
(d) FIBER

FIG. 14

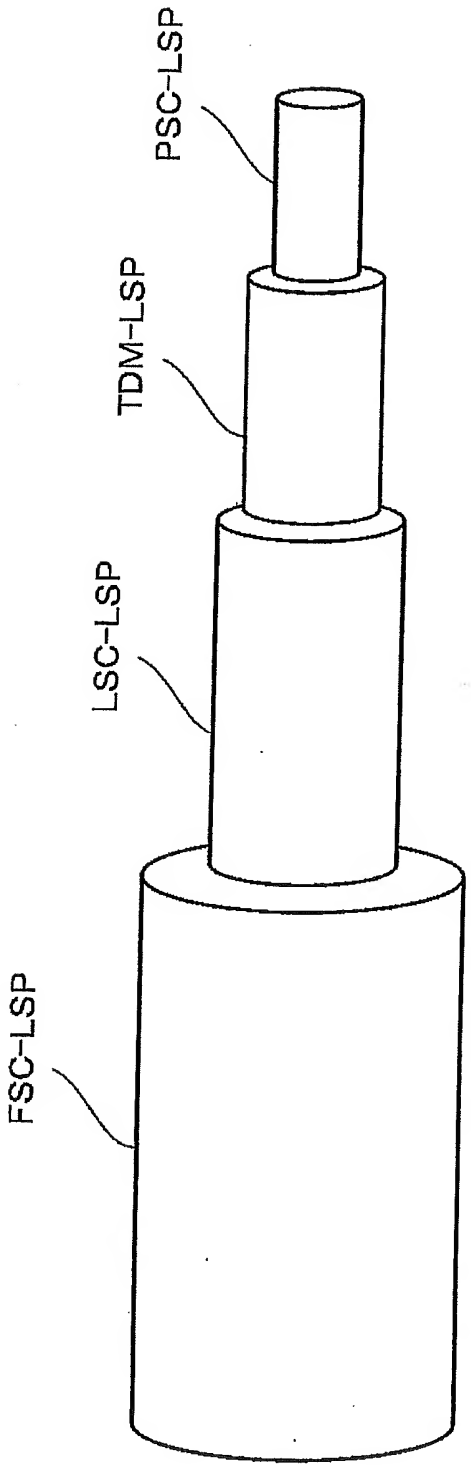


FIG.15

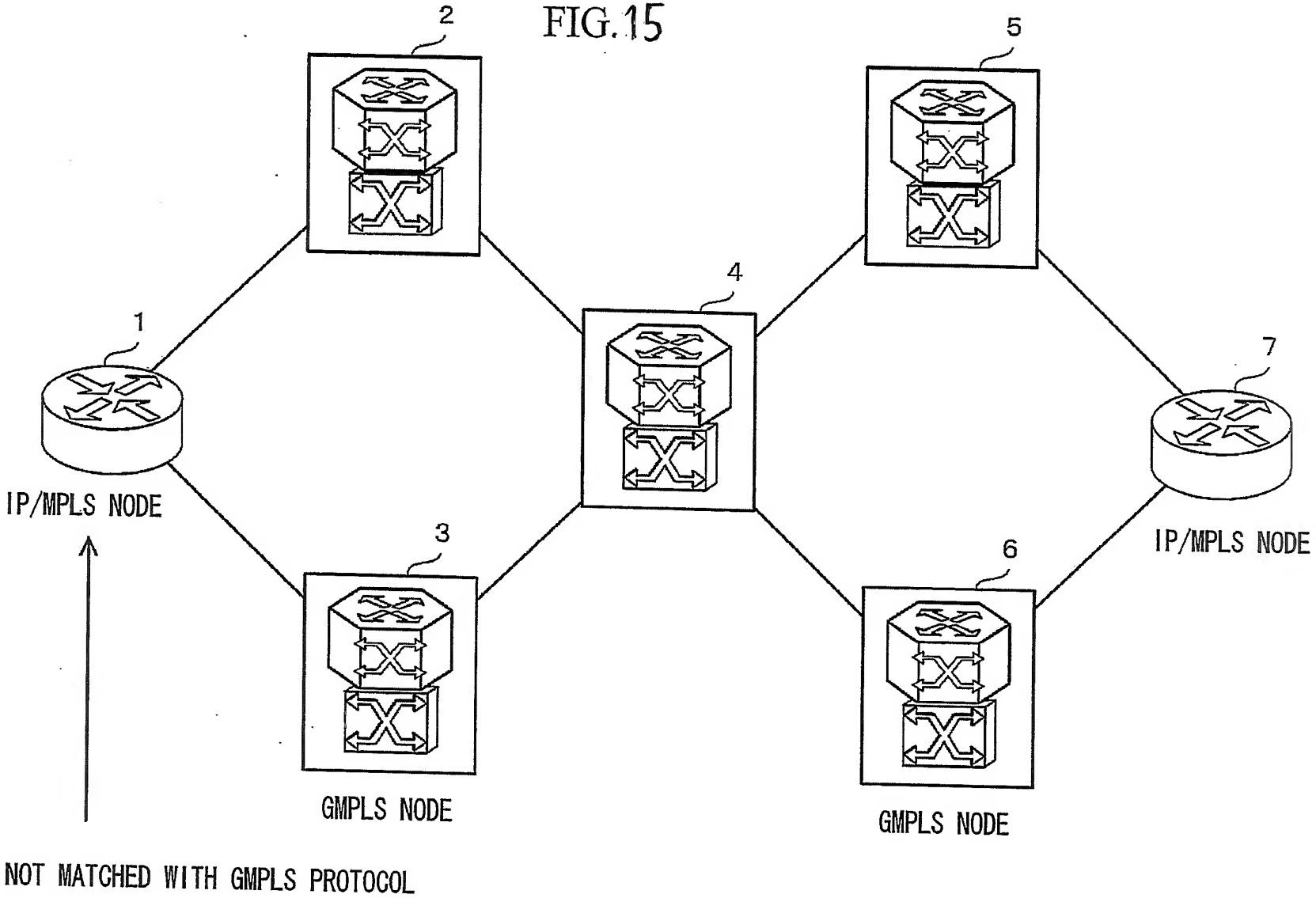

2
5
4
1
7
IP/MPLS NODE
3
6
IP/MPLS NODE
GMPLS NODE
GMPLS NODE
NOT MATCHED WITH GMPLS PROTOCOL

FIG.16

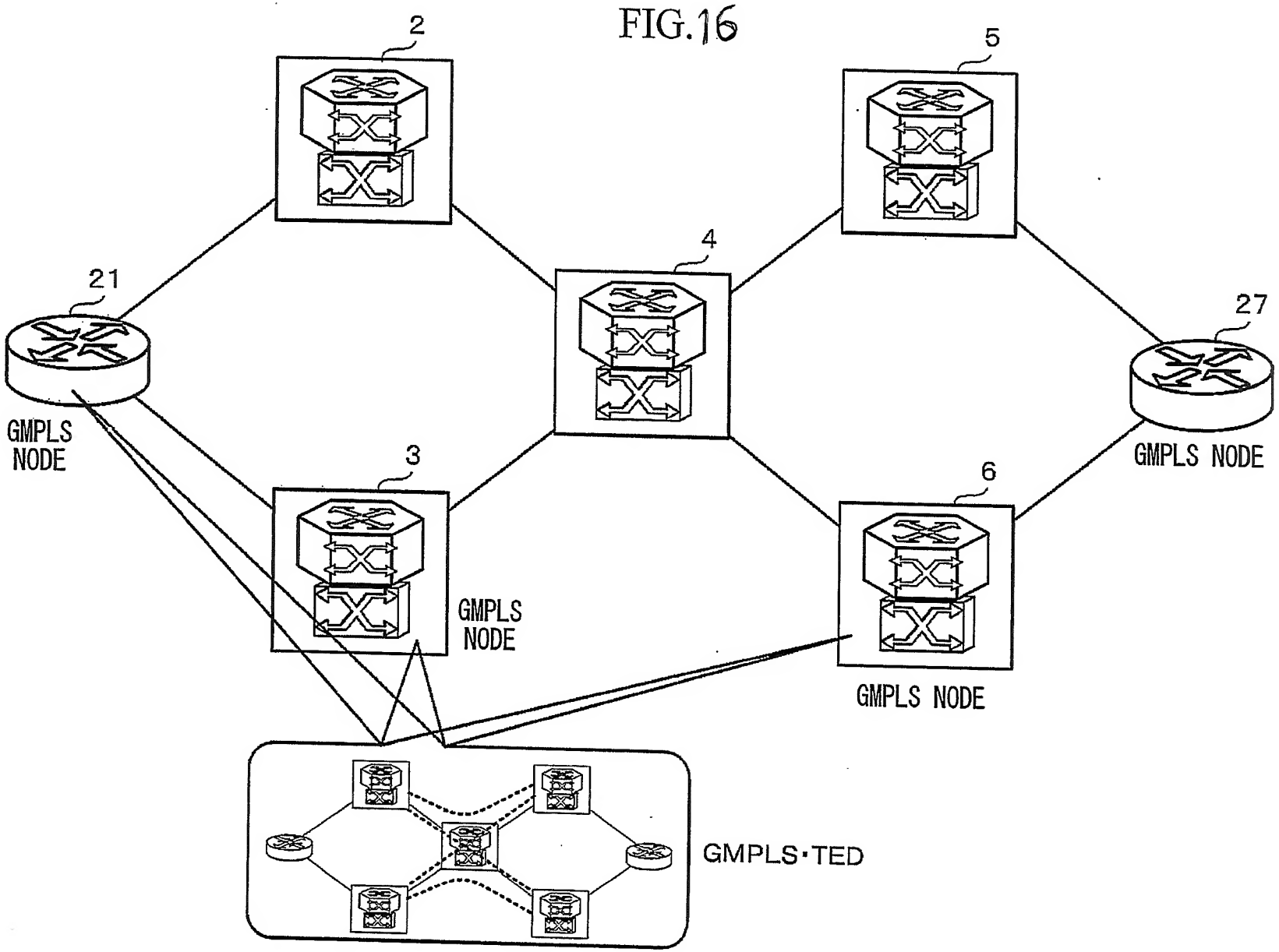

2
5
4
21
27
GMPLS
NODE
3
6
GMPLS NODE
GMPLS
NODE
GMPLS NODE
GMPLS·TED

FIG.17

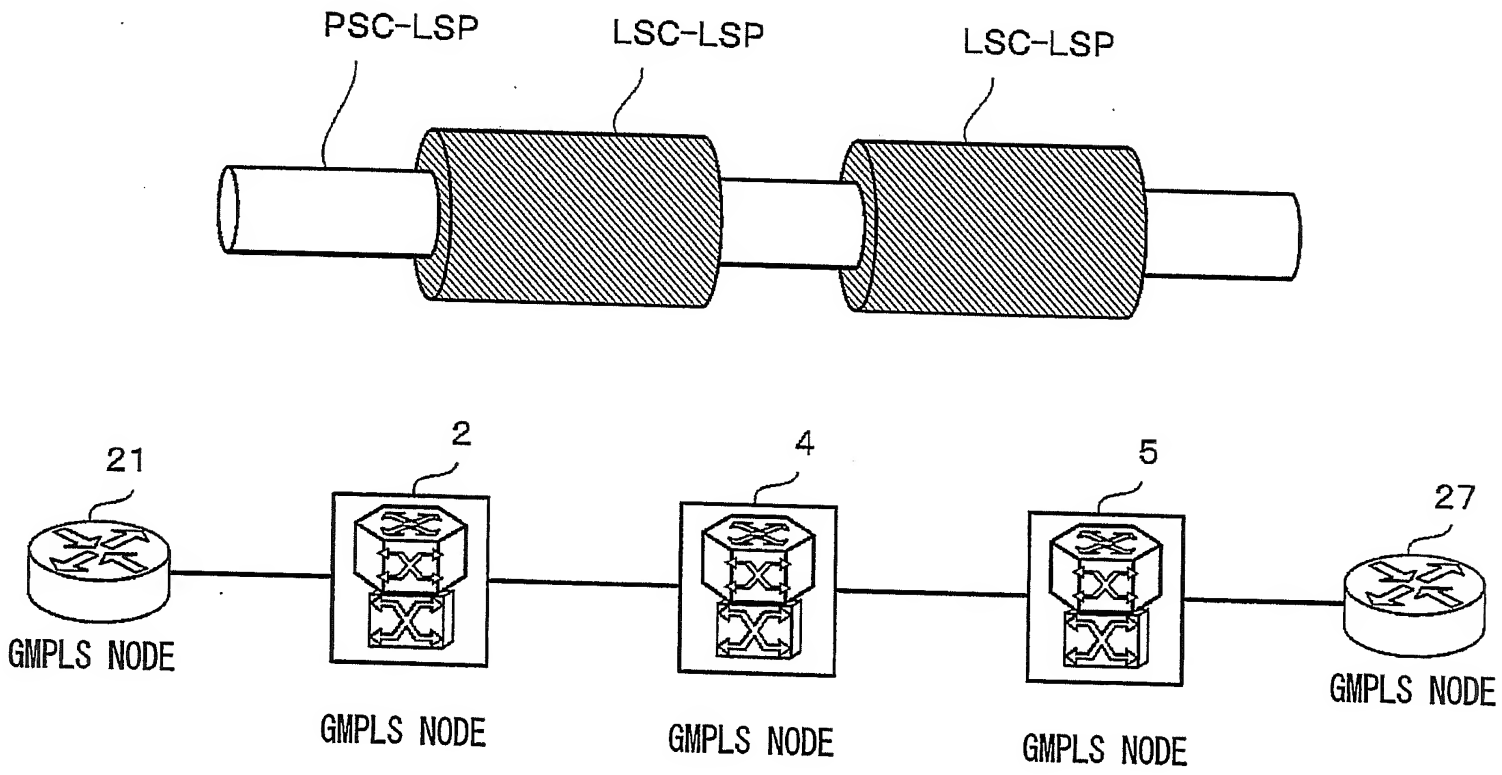
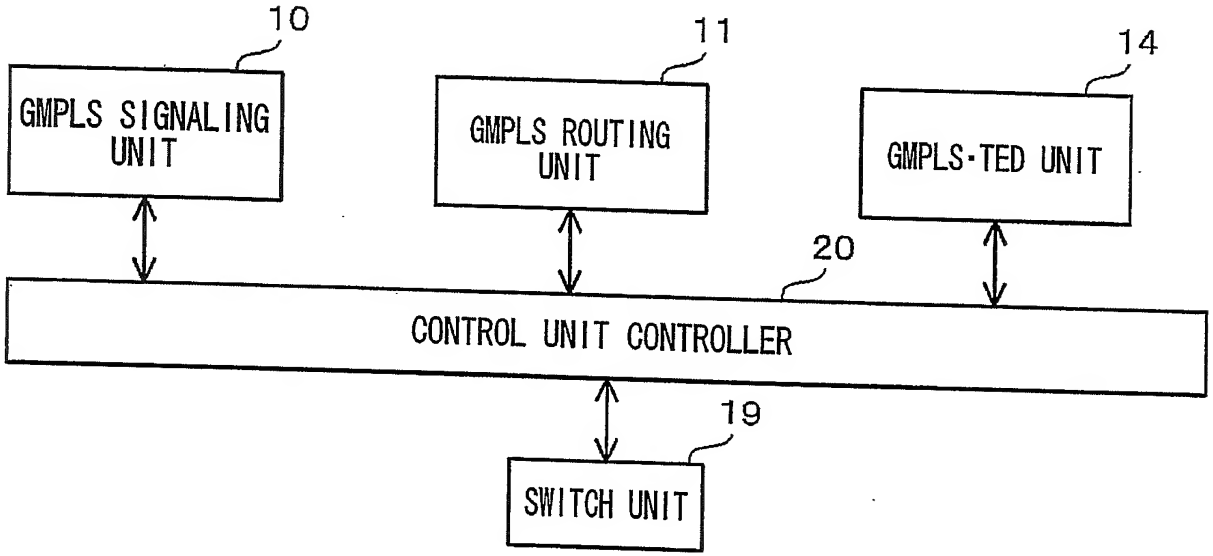

PSC-LSP
LSC-LSP
LSC-LSP
21
2
4
5
27
GMPLS NODE
GMPLS NODE
GMPLS NODE
GMPLS NODE
GMPLS NODE

FIG.18


10
GMPLS SIGNALING UNIT
11
GMPLS ROUTING UNIT
14
GMPLS-TED UNIT
20
CONTROL UNIT CONTROLLER
19
SWITCH UNIT